1 223 846

PATENT SPECIFICATION

(11) 1 223 846

DRAWINGS ATTACHED

(21) Application Nos. 28591/67 (22) Filed 21 Jan. 1967
14943/68 28 March 1968

(23) Complete Specification filed 13 June 1968

(45) Complete Specification published 3 March 1971

(51) International Classification F 16 j 15/02

(52) Index at acceptance
F2B 1B 1X10
E2B 13F1U
F2H 11A 13 15 17C

(72) Inventors JOHN EDWARD OWEN CHRISTOPHER KNAPMAN, EDGAR WILLIAM JAMES BASHAM, ALAN CAMERON MUNRO, JOHN BELLWOOD ANTHONY and GORDON POLLARD

(54) SEAL

(71) We, DIVCON INTERNATIONAL (U.K.) LIMITED, a British Company, of 9 Upper Belgrave Street, London S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the problem of coupling two vessels to each other and is particularly concerned with forming a gas-tight seal between the two vessels especially when it is very difficult to mate the connecting surfaces or flanges of the two vessels flush with each other. The problem becomes particularly acute when two heavy structures need to be joined together quickly in a gas-tight connection because it is not easy to shift one of the structures about so as to mate their respective flanges in a completely flush relationship. The apparatus of the invention may be used to connect a diving bell or chamber at high internal pressure to a decompression lock or chamber. Clearly this type of connection must be quickly done while at the same time having an absolutely gas-tight seal and with automatic compensation for missalignment of the connecting surfaces.

The diving bell and the decompression lock are very heavy structures so it is important that the device for connecting them to each other should compensate for angular missalignment of the respective flanges without having to adjust for misalignment. The present invention provides a device which is useful for making such a connection. Once the two chambers have been sealed together by use of the sealing ring, they can be held together by appropriate systems such as locking rings with or without hydraulic systems as will be hereinafter described. The operation of the locking rings is independent of, and occurs before, the seal action and subsequent pressurising of the interior.

According to the invention we provide a device for forming a seal between two bodies to be coupled together comprising means for coupling the bodies and sealing means comprising an annular sealing ring for sealing connection between the two bodies, the ring being slidably located in a recess of one of the bodies and provided with an annular resilient sealing member in an annular groove in one or both of its inner or outer surfaces adapted to form a seal between said sealing ring and said one body, a chamfer being provided on one or both of said surfaces to permit tilting of the ring with respect to said one body, the ring also being provided with an end face adapted to sealably contact the other body and means for forceably sliding the sealing ring into sealing contact between the two bodies.

In the accompanying drawings, Figure 1 is a perspective view of a portion of the annular ring used in the invention;

Figure 2 is a plan view of the annular ring in place in the face of a flange;

Figure 3 is a sectional view taken on the line A—A of Figure 2;

Figure 4 is the same view as Figure 3 but including the flanges in position to be joined and also showing a bolt and nut assembly;

Figure 5 is an exploded view of the bolt and nut assembly shown in position in Figure 4;

Figure 6 is a side-sectional embodiment of the sealing ring and locking structure;

Figure 7 is a side-sectional view of another embodiment using a thrust ring;

Figure 8 is a plan view of 180° of the thrust ring of Figure 7.

With respect to the accompanying drawings, the annular ring 1 consists of solid material which has resistance against deformation. In the preferred embodiment this ring is made of steel. The ring is movably fitted into a cut-out portion 2 of a flange 3. The rear surface of the ring is provided with an annular groove 4 and a shoulder portion 5 which restricts the forward movement of the ring by meeting a stop surface of a retaining ring 6. Opposite surfaces of the retaining ring are provided with grooves 7 and 8 to receive sealing means such as O-rings 9 and 10 which operate as seals against the surface of the retaining ring 6 and against the side 11 of the cut-out portion of the flange, respectively. In the front face of the ring there is an annular groove 12 which receives sealing means such as an O-ring 13. The front face 14 on either side of the groove 12 is slanted backwards so that they are not in the same plane. The top surface of the ring on both sides of the groove 7 are also slanted so that they are not in the same plane, the highest point of both surfaces being that at the edges of the groove. Similarly, the surfaces on either side of the groove 8 are also slanted so that they are not in the same plane, the highest point being at the edges of the groove.

A conduit 17 is provided in the flange 3. This conduit has two openings, one 18 for the injection of a fluid which may be gaseous or liquid to be forced under pressure to the opening 19. The operation of the invention is illustrated in Figure 4.

The flanges 3 and 20 of the two structures to be connected are brought into contact with each other. At this time, the flange faces are not flush and are out of parallel with each other and the ring 1 is seated in the cut-out portion 2 and there is no compressor force in the conduit 17. The bolt 21 is put in position, the washer 22 is slipped over the end of the bolt and the nut 23 is turned to finger tightness. The nut and bolt can be in an assembled condition where the bolt is simply dropped into a slot. It will be understood that there can be many of these bolts around the circumference of the flanges. A gas or fluid is then injected under pressure into the conduit 17 In the particular embodiment of the invention air was used. This fluid enters the annular groove 4 and moves the ring 1 forward until contact is made with the face of the flange 20. It is understood that the O-rings 9, 10 and 13 are made sufficiently large so that they protrude from their grooves to contact the respective opposite surfaces and form a seal. Because of the chamfering of the surfaces 15 and 16 and 14, the ring is movable so that the plane of the surface 14 on one or the other side of groove 12 approaches flush contact with the face of flange 20 and the chamfering assures that the sealing O-ring 13 will contact the opposite flange surface without the edges of the face touching the flange surface first. The compressive force applied to the ring 1 should, of course, be greater than the force within the diving bell and decompression lock so that the internal pressures will not force the ring back. It can be seen that there are effectively three surfaces which are sealed against the leakage of gas. The O-rings 9, 10 and 13 effect these seals. Thus it is seen that while the ring 1 slides in the groove in the face of the flange, the ring is still effectively sealed into this groove and when the ring is forced outwardly into engagement with an opposing flange surface an effective seal is made quickly and easily with no more than finger-tight bolts holding the two flanges together. At the same time this effective sealed connection is obtained even though the two surfaces to be joined are not flush or parallel with each other.

Referring to Figures 4 and 5, the bolt is comprised of a head 24, shaft 21, a washer 22 and a nut 23. When the bolt is in place joining the two flanges 20 and 3 it is seen that because of the angle at which their faces diverge from each other stresses i.e. bending stresses, are placed on the bolt which could weaken and perhaps break the shaft. This stress is avoided by the shaping of the face 27 of the nut 23 and its action with the surface 28 of the washer 22. The surface 27 of the nut is convex and the washer 22 has a concave, in particular spherically concave side shown as 28 and this concavity is adapted to receive the convex surface 27 of the nut. The head of the bolt also has a convex surface 25 which is adapted to sit in a concave face of the cut-out portion 26 in the flange 2. When the nut 27 is tightened rotational movement occurs between the mating convex and concave surfaces which allows the bolt to assume an angled position consistent with the misalignment of the connecting flanges. In the preferred embodiment of the invention, the two flange faces were held together by bolts which were dropped into matched oversized radial slots in both flanged faces. Such a slot is seen as 29 in Figure 2. The effect of the washer with the concave surface matching the convex surface of the nut enables a significant amount of misalignment in the horizontal and vertical

plane while still preserving axial forces in the bolts.

It will be understood that Figure 6 is simply a side section and the sealing ring 1^1 is actually a circular arrangement which sits in the recess formed at 30 of the connecting body 31 which is itself joined to the opening of the decompression chamber which would be at the right end of Figure 6. The diving bell chamber door ring is seen at 32. The ring 1^1 has a recess 33 which receives a spring 34 which is adapted to seat at the other end in a recess 35 in the bushing of connecting body 31. The faces 36 of the sealing ring 1^1 are in a 180 degree plane so that when the decompression chamber is brought forward to be connected to the diving bell, the faces 36 will fit flush with the opposite face of the ring 32. It often happens that the connecting body and bushing 31 joined to the decompression chamber is not in a perfectly parallel, opposite and flush relationship with the mating face of the diving bell. The sealing ring 1^1 is so designed that it will accommodate such a misalignment. This is accomplished by sloped faces such as seen at 46 which permits the sealing ring to tilt in the recess 30 to accommodate the mismatch but at the same time still effect the seal. O-rings 37 and 38 in appropriate recesses of the sealing ring assist in maintaining a sealing engagement between the ring 1^1 and door ring 32 and a flange of bushing 31. The spring 34 functions to hold the sealing ring in engagement with the face of the diving bell ring 32. A stop 39 is positioned in a flange surface of the bushing 31 to limit travel of the sealing ring out of the recess 30. A locking ring 40 has a tooth structure 41 which is adapted to fit into a recess 42 in the door ring 32. The locking ring 40 is adapted to be turned, for example 15 degrees, so as to fit the flange or tooth 41 into the recess 42 thus locking the bushing 31 of the connecting body to the diving bell ring 32. This turning is effected by a hydraulic system indicated at 43 and 44 which is attached on one side to the locking ring 40 and on the other to the bushing 31. In addition, a hydraulic piston 45 is connected at one end to the locking ring 40 and at the other end to a flange of the bushing structure 31. This hydraulic piston operates to bring the bushing 31 and the locking ring 40 towards each other thus effecting a locking action of the locking ring 40 with the diving bell chamber ring 32 and the connecting bushing 31. It can be seen that although no strong pressure is brought to bear on the sealing ring 1^1 from this locking action, the operation of the spring 34 and the internal pressure within the decompression chamber and the diving bell chamber functions to maintain a tight seal between the two chambers.

Figure 7 illustrates another embodiment of the invention in which the sort of sealing ring 1^1 or as shown in Figure 1 may be used. In Figure 7 the structures similar to those in Figure 1 bear the same numerals and modifications of them will be described.

The sealing ring 1^1 is shown seated in the recess 30. The bushing or housing 31 is connected to the decompression chamber which is not seen and would be at the right-hand side of Figure 7. A portion of the diving bell chamber is seen at 32 and the clamping ring is seen at 40. In this embodiment, the principle of holding the two chambers together is different. In Figure 6 the principle involved the locking of the ring 40 to the diving bell chamber ring 32 by mechanical means such as a hydraulic system which not only turned the ring 40 into locking engagement with 32 but also employed a hydraulic system to pull the two chambers towards each other. In Figure 7 the sealing function is the same. That is, the sealing ring 1^1 will effect the seal even if the two chambers are not in exact flush relationship with each other. However, the principle of the embodiment is to keep the chambers from separating rather than holding them tightly to each other. The system or connecting apparatus shown in Figure 7 need not employ any hydraulics. The housing 31 has a slanted surface which mates with a slanted surface of a thrust ring 48. The mating surfaces are seen at 49. The recess 51 in the face of the thrust ring 48 facilitates lubrication of the two mating surfaces. A locking ring 52 is integral with the ring portion 40 and this locking ring is joined to the thrust ring 48 by means of a bolt 60. The thrust ring 48 with the locking ring 52 and 40 is adapted to rotate on the sloped mating surface 49 of the housing 31. The mating surfaces between 31 and 48 are sloping. Failure to design correctly will cause large forces tending to either straighten or flex the coupling when internal pressure is applied. With this design, both angular and lateral misalignment is absorbed by rotation at 31 and 48 and sliding between 41 and 50, with no force introduced by the coupling. The chambers are joined together in the following manner. The housing 31 is brought towards the diving bell chamber ring 32 so that the sealing ring 1^1 is in contact with the face of the ring 32. The thrust ring 48 is brought into position over the mating surface 49 of the housing 31 with the tooth portion of the locking ring 40 engaged with the tooth recess 50 of the diving bell chamber ring 32. The thrust ring 48 and assembly lock-

ing ring 52 and 40 is rotated through about a 15 degree angle so as to engage the tooth 40 within the recess 50 of the ring 32. A guide wheel 53 has a flange portion 54 and this guide wheel is fastened by means of an appropriate washer and gasket to the housing of the decompression chamber. It can be seen that the wheel 53 has a sloping surface to engage a raised guide member 55 which is mounted on the thrust ring 48. As seen in Figure 8, the thrust ring has stops 56 at each end of the guide member 55. When the thrust ring 48 and locking ring 40 and 52 assembly is rotated to engage the diving bell chamber ring 32, the stops 56 limit the turning motion by engaging the wheel 53. When the chambers are joined together there is no pressure within them. After they have been joined together as just described, pressure is inserted. This internal pressure forces the seal ring into tighter engagement with the portion 32 of the diving chamber but this pressure does not escape around the sealing ring because of the nature of its construction as described above. It can be seen that this pressure acts in a direction tending to force the diving chamber and the decompression chamber apart. However, because of the slanted mating faces of the housing 31 and the thrust ring 48 and the locking action of the locking ring 40 engaging the diving bell 32, it can be seen that the chambers are prevented from being forced apart, and the spring pressure initially sealing the ring is reinforced by the pneumatic force resulting from the application of internal pressure.

WHAT WE CLAIM IS:

1. A device for forming a seal between two bodies to be coupled together comprising means for coupling the bodies and sealing means comprising an annular sealing ring for sealing connection between the two bodies, the ring being slidably located in a recess of one of the bodies and provided with an annular resilient sealing member in an annular groove in one or both of its inner or outer surfaces adapted to form a seal between said sealing ring and said one body, a chamfer being provided on one or both of said surfaces to permit tilting of the ring with respect to said one body, the ring also being provided with an end face adapted to sealably contact the other body and means for forceably sliding the sealing ring into sealing contact between the two bodies.

2. A device as claimed in claim 1, in which an annular groove in the end face contains an annular resilient sealing member for sealing the sealing ring with said other body and annular grooves in both the inner and outer surfaces contain annular resilient sealing members adapted to seal between said sealing ring and said one body.

3. A device according to claim 2, wherein there is an annular channel in the surface of the ring opposite the end face.

4. A device according to claim 2 or 3, wherein the end face is chamfered symmetrically on each side of the groove.

5. A device according to claim 2, 3 or 4, wherein the inner and outer surfaces are chamfered symmetrically on each side of their respective grooves.

6. A device according to claim 2, 3, 4 or 5, having a stop shoulder to limit sliding movement of the ring.

7. A device according to claim 1, in which the end face is provided with a portion adapted to be mated in flush engagement with the other of the two bodies to be coupled.

8. A device according to claim 7, wherein a recess is provided in the other end face of the ring to receive a resilient member adapted to act between the two bodies to force the flush-mating portion against the other of the bodies to be coupled.

9. A device according to any one of the preceding claims 1 to 8, including a coupling member for coupling the two bodies to each other, the member having a recess for the sealing ring said coupling member being coupled to a rotatable locking ring having a tooth portion for engagement with a body to be coupled.

10. A device according to claim 9, wherein the locking ring is connected with a hydraulic system to rotate the ring into locking engagement with a body to link the body with another body and to draw the two bodies towards each other, with a sealing ring between the two bodies to seal off air pressure escape from the bodies.

11. A device according to claim 10, the coupling member including a thrust ring having a slanted surface for mating with a slanted surface on the housing or bushing of one body, the member also being joined to the locking ring for locking on to a toothed structure on the other body, whereby the locking and the slanted mating surfaces prevent separation of the two bodies.

12. A device according to claim 11, including a rigid clamp ring extending from the locking ring to the housing or bushing.

13. A device according to any one of claims 1 to 12 substantially as herein described with reference to the accompanying drawings.

Agents for the Applicants,
MATTHEWS, HADDAN & CO.,
Chartered Patent Agents,
31/32, Bedford Street,
Strand,
London, W.C.2.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1971.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

1223846 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig.1.

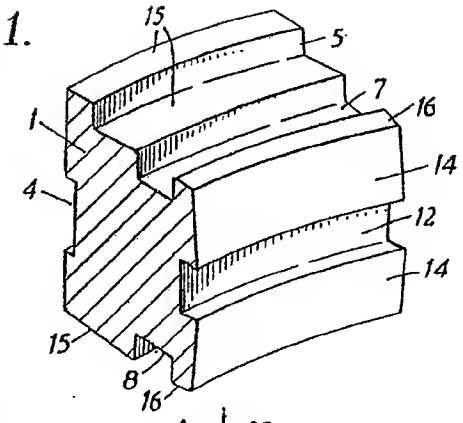


Fig.2.

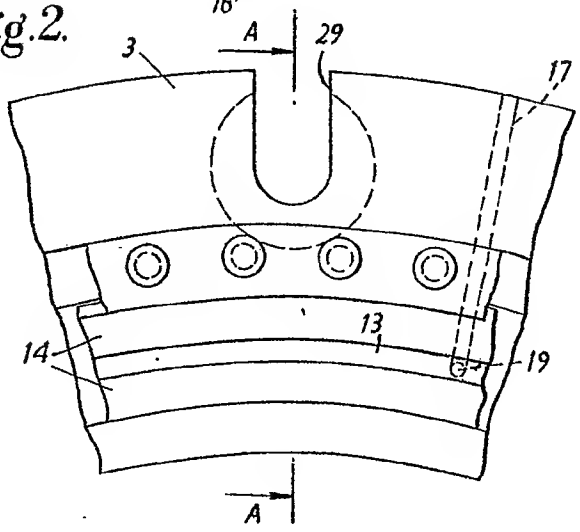


Fig.3.

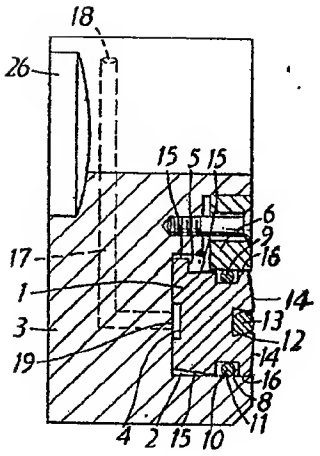
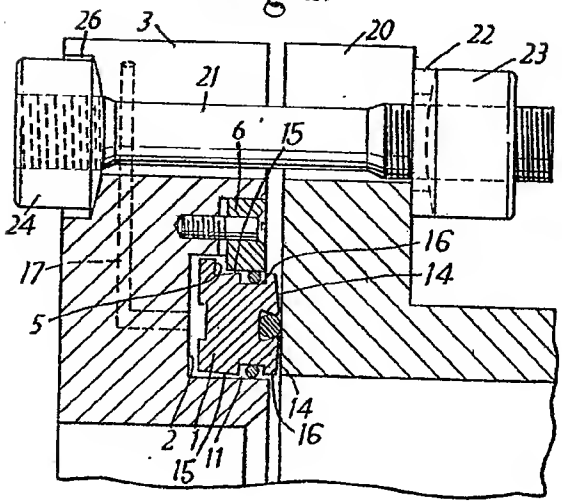

18
26
15 5 15
6
9
16
17
1
14
13
3
12
19
14
16
8
11
4 2 15 10

Fig.4.


26
3
20
22
23
21
6
15
24
16
17
14
5
14
16
2 1 11
15

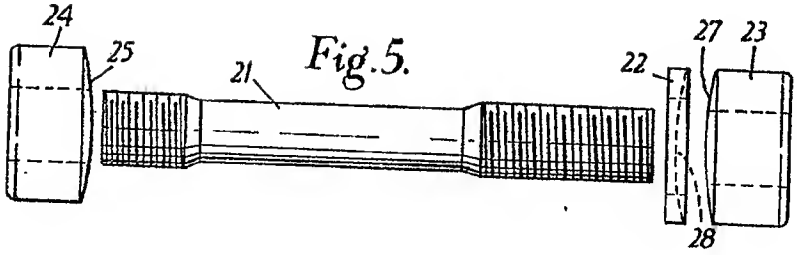

24
25
21
22
27
23
28

Fig.5.

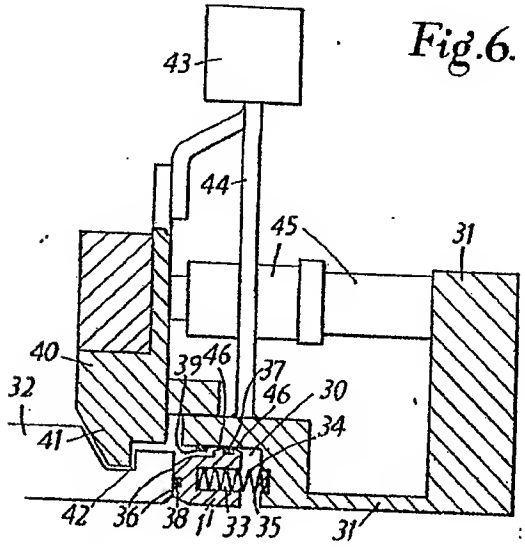

43
44
45
31
40
39
46
37
46
30
32
34
41
42
36
38
33
35
31

Fig.6.

Fig. 7.

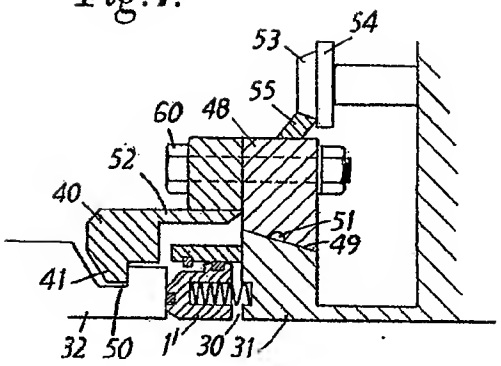


Fig. 8.